Functionalization of mesoporous silica material (SBA-15-type) with polyether chains as a strategy for controlling antibiotic delivery

Murilo I. Santos (IC), Karim Bouchmella (PQ), Mateus B. Cardoso (PQ)

Abstract

Adsorption studies of tetracycline on the mesoporous silica SBA-15 functionalized with polyether chains (PE) in various proportions (ranging from 0.1 to 0.8 mol%) were performed. Thermogravimetric Analysis (TGA) showed influence of initial concentration of tetracycline on the loading. N₂ adsorption/desorption showed that pore volume (Vp) and specific surface area (SSA) decrease after drug encapsulation.

Key words: SBA-15, Tetracycline, Drug Delivery System

Introduction

Mesoporous silica materials present high potential as drug carriers due to high pore volume and superficial area,¹ which can allow the adsorption of large amounts of drugs in the structures. Additionally, the surface functionalization of silica permits the inclusion of moieties or ligands that can improve pharmacokinetic properties of solids and mediate selective interactions with cells and microorganisms.² In this sense, our purpose is to produce a hybrid organic-inorganic material based on the silica SBA-15 functionalized with polyether chains aiming at the delivery of antibiotics.

Results and Discussion

The synthesis method (Image 1) is based on the polycondensation of TEOS and bis-silylated pluronic P123. One pure SBA-15 sample and 4 samples with (bis-silylated P123)/(bis-silylated P123+P123) ratio ranging from 0.1 to 0.8 mol % were prepared.

![Image 1. Scheme of the synthesis of silica SBA-15-based materials.](image)

N₂ Adsorption/Desorption (Chart 1) points out the influence of PE chains proportion in the surface area - SSA and pore volume - Vp. TGA analyses (Image 2) show that the amount of adsorbed drug increase when concentration is 10 mg/mL rather than 50 mg/mL. Following the material and the initial concentration of tetracycline, drug loading is in the range of 20-35 wt%.

![Image 2. TGA after tetracycline encapsulation (10 and 50 mg/mL) at ambient conditions for 24h.](image)

Chart 1. N₂ Adsorption/Desorption. Before (Black) and after (red) drug encapsulation (50 mg/mL)

<table>
<thead>
<tr>
<th>Tetracycline 50mg/mL</th>
<th>BET Surface Area SSA (m² g⁻¹)</th>
<th>Pore Volume (cm³ g⁻¹)</th>
<th>Average Pore Width (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBA-15</td>
<td>750 / 370</td>
<td>1.3 / 0.7</td>
<td>7/7</td>
</tr>
<tr>
<td>0.1mol%PE</td>
<td>650 / 240</td>
<td>1.2 / 0.4</td>
<td>7/7</td>
</tr>
<tr>
<td>0.2mol%PE</td>
<td>570 / 250</td>
<td>1.1 / 0.5</td>
<td>8/7</td>
</tr>
<tr>
<td>0.4mol%PE</td>
<td>430 / 230</td>
<td>0.9 / 0.5</td>
<td>9/8</td>
</tr>
<tr>
<td>0.8mol%PE</td>
<td>280 / 180</td>
<td>0.7 / 0.4</td>
<td>11/9</td>
</tr>
</tbody>
</table>

Conclusions

An original synthesis method is proposed. The produced materials enable high SSA and high drug loading (20-35 wt%).

Acknowledgement

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¹Yang, P. The Chemistry of Nanomaterials, World Scientific, 2003;
³Wittig, R. et. al. Nanomedicine, 2014, 9(7), 971-978;

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